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NORTH CAROLINA AIR QUALITY MAINTENANCE AREA ANALYSIS

VOLUME IV. PROJECT SUMMARY AND RECOMMENDATIONS FOR THE CHARLOTTE, WINSTON-SALEM, AND GREENSBORO AQMA'S FOR 1973, 1975, 1980, AND 1985

North Carolina Department of Natural and
Economic Resources

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FINAL REPORT

VOLUME IV

PROJECT SUMMARY AND RECOMMENDATIONS
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AQMA'S FOR 1973, 1975, 1980, AND 1985

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This report is a narrative summary of the North Carolina Air Quality Maintenance Area (AQMA) analysis. Discussed are: (1) Federal rulemaking with regard to AQMA analysis; (2) results of the distinct but interrelated technical phases of the analysis detailed in volumes I, II, and III of this study; (3) conclusions and interpretations of the analysis results, including possible validity factors to be used in projecting emissions and air quality; and (4) recommendations for a continuing maintenance analysis program through the North Carolina Air Quality Section proposes to track associated growth and periodically reanalyze future air quality.

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FINAL REPORT

Prepared By

AIR QUALITY SECTION
DIVISION OF ENVIRONMENTAL MANAGEMENT
DEPARTMENT OF NATURAL AND ECONOMIC RESOURCES
STATE OF NORTH CAROLINA

RALEIGH, NORTH CAROLINA
MAY 1976

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ABSTRACT

This report is a narrative summary of the North Carolina Air Quality Maintenance Area (AQMA) analysis. Discussed herein are: (1) the Federal rulemaking leading to the procedural requirements for AQMA analyses; (2) the results of the three distinctive but interrelated technical phases of the analysis which are detailed in separate volumes; (3) conclusions and interpretations of the analysis results, including possible validity factors related to the projection of emissions and the estimation of future air quality; and (4) recommendations of a continuing maintenance analysis program through which the North Carolina Air Quality Section proposes to track associated growth and periodically reanalyze future air quality. This report also presents a discussion of a unique comparison between dispersion modeling predicted TSP concentrations and observed TSP concentrations for the projection year of 1975.

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1. INTRODUCTION

The Air Quality Section, Division of Environmental Management, Department of Natural and Economic Resources (NCAQS) in order to satisfy the requirements pertaining to the analysis of Air Quality Maintenance Areas (AQMAs) pursuant to 40 CFR 51.12 as amended and promulgated in the Federal Register of May 3, 1976, (41 FR 18387) is submitting to the Environmental Protection Agency (EPA) an analysis of the three AQMAs in North Carolina. The Charlotte AQMA (Mecklenburg County), the Winston-Salem AQMA (Forsyth County), and the Greensboro AQMA (Guilford County) have been identified by the Administrator in 40 FR 18735 of April 29, 1975, as having the potential for violation of the National Ambient Air Quality Standards (NAAQS) for total suspended particulate matter (TSP) within ten years. The AQMA analysis is presented in the format of four distinct but interrelated volumes, (Volumes I-IV) each under the primary title heading of North Carolina Air Quality Maintenance Area Analysis. Volumes I, II, and III relate detailed descriptions of the procedures and results of the three overlapping technical phases of the analysis. This report, Volume IV, is designed to serve as a narrative summary of the entire project effort. Covered are a discussion of the Federal rulemaking leading to the procedural requirements for all AQMA analyses, conclusions and interpretations of the results of the North Carolina AQMA analysis, discussions of possible validity factors related to the projection of emissions and the estimation of future air quality, and recommendations of a program in which the NCAQS personnel propose to conduct data refinements through a continuing procedure of tracking associated growth and reassessments through further research and modeling.

Volume I: TSP Area Source Emission Inventories for Charlotte, Winston-Salem, and Greensboro AQMAs for 1973, 1975, 1980, and 1985 describes the tasks completed by Engineering-Science, Inc. (ES) of McLean, Virginia, as performed under Basic Ordering Agreements (BOA) Contract 68-02-1380, Task Order No. 7 to the EPA, Region IV. The scope of ES's work, which began in November 1974, was to assist the NCAQS in the analysis phase of the air quality maintenance program to the extent of the following four activity areas:

1. Update of the 1973 baseline year area source emission inventory;
2. Allocation of the baseline year area source emission inventory to subcounty and/or Air Quality Display Model (AQDM) grid squares;
3. Projection of county or subcounty area source emission inventories to 1975, 1980, and 1985;
4. Allocation of the projected area source emission inventories to subcounty and/or AQDM grid squares.

Volume I details the methodologies and procedures and explains the rationale for all assumptions made during the four activity phases of the area source analysis. ES's efforts have resulted in the completion of computer load sheets for use in the AQDM, covering all area source categories for the three AQMAs for the base year 1973 and the projection years 1975, 1980, and 1985.

Volume II: TSP Point Source Emission Inventories, TSP Monitoring Data and Meteorological Data for Charlotte, Winston-Salem and Greensboro AQMAs for 1973, 1975, 1980 and 1985 explains the procedures and results of the following four activities for which the NCAQS personnel had sole responsibility:

1. Update of the 1973 baseline year point source emission inventories and projection of same to 1975, 1980, and 1985;

2. Compilation of appropriate meteorological and climatological AQDM input parameters;

3. Validation and modification of ambient monitoring data;

4. Rejection analysis of ambient monitoring sites.

Volume II details the methodologies incorporated in accomplishing these four activities and expiains the rationale for all variations from the procedures suggested by EPA AQMA guidelines. The work described in Volume II has resulted in complete point source emission inventories and appropriate meteorological parameters for 1973, 1975, 1980, and 1985, refined 1973 air quality monitoring data, and the identification of appropriate monitoring stations for 1973 for use in the AQDM calibration procedure.

Volume III: TSP Dispersion Modeling and Analysis for Charlotte, Winston-Salem, and Greensboro AQMAs for 1973, 1975, 1980, and 1985 describes the tasks completed by Research Triangle Institute (RTI) of Research Triangle Park, North Carolina as performed under BOA Contract 68-02-1386 Task Order No. 15 to the EPA, Region IV. The scope of RTI's work, which began in May 1975, was to assist the NCAQS in the analysis phase of the air quality maintenance program. Their assistance included modeling the ambient air quality concentrations for the baseline or calibration year of 1973 and the projected years of 1975, 1980, and 1985 for the three AQMAs in North Carolina. Volume III explains the AQDM modeling parameters incorporated, the calibration procedures used, and the rationale for all systematic modifications and variations of the computational AQDM runs. The work described in Volume III has resulted in acceptable calibrations of the AQDM for 1973 for the areas modeled, giving relative confidence in prediction capability for future years of interest. Volume III presents the TSP concentration isopleth maps and analyses for each of the three AQMAs for 1973, 1975, 1980, and 1985.

2. FEDERAL RULEMAKING

In 1973, the Natural Resources Defense Council, Inc. (NRDC) challenged the Administrator's approval of all State implementation plans in the United States Court of Appeals for the District of Columbia Circuit on the grounds that the plans approved in the Federal Register of May 31, 1972 (37 FR 10842), were not adequate to ensure maintenance of the NAAQSs, once the standards were attained. As a result of the subsequent Court ruling in NRDC V. EPA, 475 F. 2d968 (D.C. Cir. 1973), the Administrator conducted reviews of all plans and determined that no State plan contained adequate provisions to ensure the maintenance of the standards, nor did any plan adequately address the impact of demographic and economic growth on future air quality. The Administrator, therefore, on March 8, 1973 (38 FR 6279), disapproved all State implementation plans with respect to maintenance of the NAAQSs.

In concurrence with public comments, the Administrator determined that even expanding the scope of existing provisions available under the Act and in regulations, covering such areas as new and modified stationary source preconstruction review, new source performance standards, and motor vehicle emission standards, could not adequately deal with the impact of generalized growth of population, industrial activity, and mobile sources on regional air quality. The Administrator, therefore, decided that States should be specifically required to conduct comprehensive area wide growth analyses in addition to reviewing new and modified sources and, whenever necessary, revise the State plan to assure maintenance of standards. On June 18, 1973 (38 FR 15834), the Administrator promulgated such requirements amending 40 CFR 51.12.

As further amended on May 8, 1974 (39 FR 16343), 40 CFR 51.12 required that States must identify by May 10, 1974, all areas which have the potential for exceeding any NAAQS within ten years as a result of current air quality and/or projected growth. From this identification, the Administrator would subsequently

designate in the Federal Register all areas having the potential for violation, by 1985, of specified NAAQSs. By June 18, 1975, each State was to submit a detailed analysis of the impact of projected growth on air quality in each designated AQMA. Where such analysis indicated that any primary or secondary NAAQS would not be maintained for the following ten years, the State was to submit a plan which would contain provisions to ensure such maintenance. The States would also be required to perform the identification/analysis/plan development process at least every five years.

On July 10, 1974 (39 FR 25330), the Administrator, as required by 40 CFR 51.12 as amended, proposed a list of AQMAs for all States except those in EPA Region V. The proposal of the AQMAs in Region V were made on August 12, 1974 (39 FR 28906). Final designation of the AQMAs in many States, including North Carolina, was made in the Federal Register of April 29, 1975 (40 FR 18726). The remaining AQMA designations were made on June 2, 1975 (39 FR 18726), and on September 9, 1975 (40 FR 41941). A total of 168 AQMAs with regard to one or more pollutants were identified; of these, 159 areas were designated for particulate matter, 61 areas for sulfur dioxide, 24 areas for carbon monoxide, 49 areas for photochemical oxidants, and 5 areas for nitrogen dioxide.

In the Federal Register of June 19, 1975 (40 FR 25814), the Administrator rescinded the June 18, 1975 date for submission of analyses and plans and chose to specify, at his discretion, separate submittal dates for each AQMA analysis and subsequent plan, if a plan was found to be necessary depending upon the individual needs of each area. It was provided that each State would submit AQMA analyses in advance of July 1, 1976, (specifically April 1, 1976, or as modified by the Administrator), in sufficient time for the Administrator to review such analyses and determine by July 1, 1976 which AQMAs need implementation plan revisions to ensure maintenance. The submittal date for North Carolina's AQMA analysis in final form has been specified by the Region IV Administrator as June 1, 1976.

In the Federal Register of October 20, 1975 (40 FR 49048), the Administrator first proposed specific regulations pertaining to the analysis and development of plans for all AQMAs. This proposal outlined the minimum requirements for the content and format of AQMA analyses and of attainment plan revisions as found to be necessary in AQMA areas.

On May 3, 1976 (41 FR 18382), the Administrator promulgated, in final form, an amended version of the October 20, 1975, proposed regulations concerning the procedures to be used for estimating future air quality concentrations and for developing new control strategies necessary to ensure the maintenance of the NAAQSs. The regulations found in 41 FR 18382 were designed as a suggested framework for the technical and proceedural steps necessary to preform acceptable analyses and plan revisions to ensure that public health and welfare be protected through the maintenance of the standards. The regulations have not been designed to direct substantive measures needed for maintenance of standards, but leave such choices and interpretations to the State.

3. CALCULATED AIR QUALITY

3.1 OVERVIEW

Volumes I, II, and III culminated in the projection and allocation of emissions and the calculation of air quality concentrations for 1973, 1975, 1980, and 1985 in the Charlotte, Winston-Salem, and Greensboro AQMAs in North Carolina. This section is a synopsis of these Volumes. Wherever possible, the technical procedures and format followed during all phases of the analysis adhered to those suggested in the draft proposal in the Federal Register of October 20, 1975 (40 FR 49048), and the EPA Guidelines for Air Quality Maintenance Planning and Analysis. Any deviations in the methodologies and procedures suggested by the EPA literature are detailed and their rationale explained in the related volumes of the analysis. All new or modified analytical techniques have been discussed with and approved by the EPA Region IV Project Officer prior to their incorporation into the analysis. As this Volume is designed to serve as a summary of the results of the total analysis effort, details of the technical work and computation methods leading to these results are not included and may be found in Volumes I, II, and III.

The reader is cautioned from a strict interpretation of the projected emissions and air quality concentrations for 1975, 1980, and 1985 presented in this section, in that the accuracy of projecting to future years with specific date representations is dependent upon the accuracy of a number of demographic, economic, meteorological, and computational parameters which are subject to variabilities. Such variabilities must be understood prior to drawing firm conclusions from any prediction modeling effort. Section 4, VALIDITY FACTORS, identifies and discusses those variables in the analysis which may have had substantial effects on the results described herein.

3.2 ANALYSIS RESULTS

3.2.1 GENERAL

The Winston-Salem and Greensboro AQMAs were modeled together because of a common geographical boundary and the availability of a single set of meteorological data. However, the Charlotte AQMA was modeled independently. The year 1973 was used as the calibration year for the AQDM. Calibration procedures are described in detail in Volume II. Mean annual stability wind roses for 1973 were used in the calibration proceedures, and long-term mean annual stability wind roses were used for all projection years. Modified meteorological data, representing only those days on which high-volume sampling had been conducted in 1973, was used in the calibration procedure for both areas modeled. A detailed study of all monitoring sites was made in an effort to identify those most suitable for calibration purposes. Both the modified meteorological data and the monitoring site analysis are discussed in detail in Volume II.

Tables I, II, and III give total emission inventory summaries for each AQMA for all years modeled. Most of the emissions in each AQMA are found to be from area sources, and the majority of the area source emissions can be attributed to the inclusion of fugitive dust emissions from paved and unpaved roads. The area source categories considered in Volume I which had zero emission estimates are excluded from these summary tables. Figures I, II, and III the grid networks to which the area source emissions compiled for each AQMA for all years modeled were assigned during the allocation/apportionment procedure detailed in Volume I.

The State and National Ambient Air Quality Standards for annual TSP concentrations are 60 ug/m^3 and 75 ug/m^3, respectively. These standards are expressed as annual geometric means. It should be noted that, because of inherent characteristics of the AQDM, the average concentrations calculated by the model are annual arithmetic means.

Arithmetic means are slightly greater than corresponding geometric means. This should be considered when comparing AQDM calculated concentrations to the standards.

TABLE I

EMISSION SUMMARY FOR THE CHARLOTTE AQMA

(Tons/Year)

	1973	1975	1980	1985
Area Sources				
Total	19108.0	20124.5	22741.2	25226.5
Paved Roads	9413.3	10542.7	13366.9	15908.6
Unpaved Roads	7116.5	6805.8	6090.7	5449.6
Light Duty Vehicles	1072.6	1201.3	1523.1	1812.7
Heavy Duty Gas Vehicles	104.2	116.7	148.0	176.1
Heavy Duty Diesel Vehicles	125.9	141.0	178.8	212.8
Aircraft	26.5	27.9	31.6	36.9
Railroad Engine	27.6	29.6	35.1	41.7
Railroad Yards	3.5	3.7	4.5	5.3
Diesel Construction	60.8	63.8	71.1	83.9
Small Gasoline Engine	26.3	27.9	31.3	36.4
Farm Tractors	3.9	3.4	2.3	0.2
Residential Fuel	222.1	235.0	263.6	329.7
Commercial/Institutional Fuel	265.7	275.0	299.4	326.3
Industrial Fuel	318.1	321.6	343.2	409.1
Open Burning	31.9	31.9	31.8	31.7
Incineration	22.0	22.8	24.8	27.0
Structural Fires	17.7	18.8	21.1	25.8
Unpaved Airstrips	12.5	14.4	19.7	30.5
Tilling	30.7	27.0	18.4	1.2
Construction	146.2	153.5	171.1	201.8
Area Source Process Losses	60.0	60.7	64.7	77.2
Point Sources				
Total	35286.0	5423.4	6111.2	6304.9
Known in Place Growth	35286.0	5416.4	6090.2	6260.9
New Unknown Growth	-------	7.0	21.0	44.0
Total Emissions	54394.0	25540.9	28852.4	31531.4

TABLE II

EMISSION SUMMARY FOR THE WINSTON-SALEM AQMA

(Tons/Year)

	1973	1975	1980	1985
Area Sources				
Total	24156.8	23469.5	22438.9	22080.9
Paved Roads	7198.5	7990.5	10006.0	11949.5
Unpaved Roads	15665.0	14110.9	10859.1	8358.1
Light Duty Vehicles	567.2	629.6	788.4	941.6
Heavy Duty Gas Vehicles	61.7	68.5	85.8	102.4
Heavy Duty Diesel Vehicles	74.3	82.5	103.3	123.3
Aircraft	7.1	8.2	9.5	11.5
Railroad Engine	6.7	7.2	8.5	10.1
Railroad Yards	0.8	0.9	1.0	1.2
Diesel Construction	6.6	7.0	7.8	8.5
Small Gasoline Engine	15.5	15.8	16.7	17.5
Farm Tractors	27.2	26.1	22.6	19.9
Residential Fuel	199.9	202.3	209.9	215.4
Commercial/Institutional Fuel	37.6	43.1	48.6	51.5
Industrial Fuel	56.6	57.1	57.6	59.0
Open Burning	63.8	49.3	44.1	40.4
Incineration	9.0	10.3	11.6	12.3
Structural Fires	13.8	14.1	14.9	15.6
Tilling	65.7	63.1	54.5	48.0
Construction	47.8	50.7	56.4	61.7
Area Source Process Losses	32.0	32.3	32.6	33.4
Point Sources				
Total	1746.3	957.5	1065.1	1115.0
Known in Place Growth	1746.3	957.5	1065.1	1108.0
New Unknown Growth	------	0.0	0.0	7.0
Total Emissions	25903.1	24427.0	23504.0	23195.9

TABLE III

EMISSION SUMMARY FOR THE GREENSBORO AQMA

(Tons/Year)

	1973	1975	1980	1985
Area Sources				
Total	37720.3	36610.4	34919.7	34286.7
Paved Roads	10914.5	11879.0	14516.5	17245.0
Unpaved Roads	24580.8	22419.6	17810.0	14148.3
Light Duty Vehicles	851.4	928.0	1132.4	1345.2
Heavy Duty Gas Vehicles	100.7	109.8	133.9	159.1
Heavy Duty Diesel Vehicles	121.3	132.2	161.3	191.7
Aircraft	16.1	16.7	19.0	22.3
Railroad Engine	35.5	38.0	45.2	53.6
Railroad Yards	4.4	4.7	5.6	6.6
Diesel Construction	10.7	11.1	12.5	14.1
Small Gasoline Engine	21.0	21.2	22.7	24.2
Farm Tractors	59.9	58.7	49.7	41.3
Residential Fuel	373.7	373.2	388.9	405.2
Commercial/Institutional Fuel	35.0	36.9	41.5	46.2
Industrial Fuel	77.6	80.0	86.1	92.2
Open Burning	99.7	77.6	68.3	59.6
Incineration	12.2	12.8	14.5	16.1
Structural Fires	21.6	21.8	23.3	24.8
Tilling	156.0	152.9	129.5	107.6
Construction	105.2	109.4	123.1	138.9
Area Source Process Losses	121.0	124.8	134.2	143.7
Wild Forest Fires	2.0	2.0	1.5	1.0
Point Sources				
Total	3088.1	4325.1	4119.2	4539.0
Known in Place Growth	3088.1	3897.1	3569.2	3726.0
New Unknown Growth	------	428.0	550.0	813.0
Total Emissions	40808.4	40935.5	39038.9	38825.7

FIGURE I

CHARLOTTE AQMA: AREA SOURCE GRID NETWORK

(UTM Coordinates Shown)

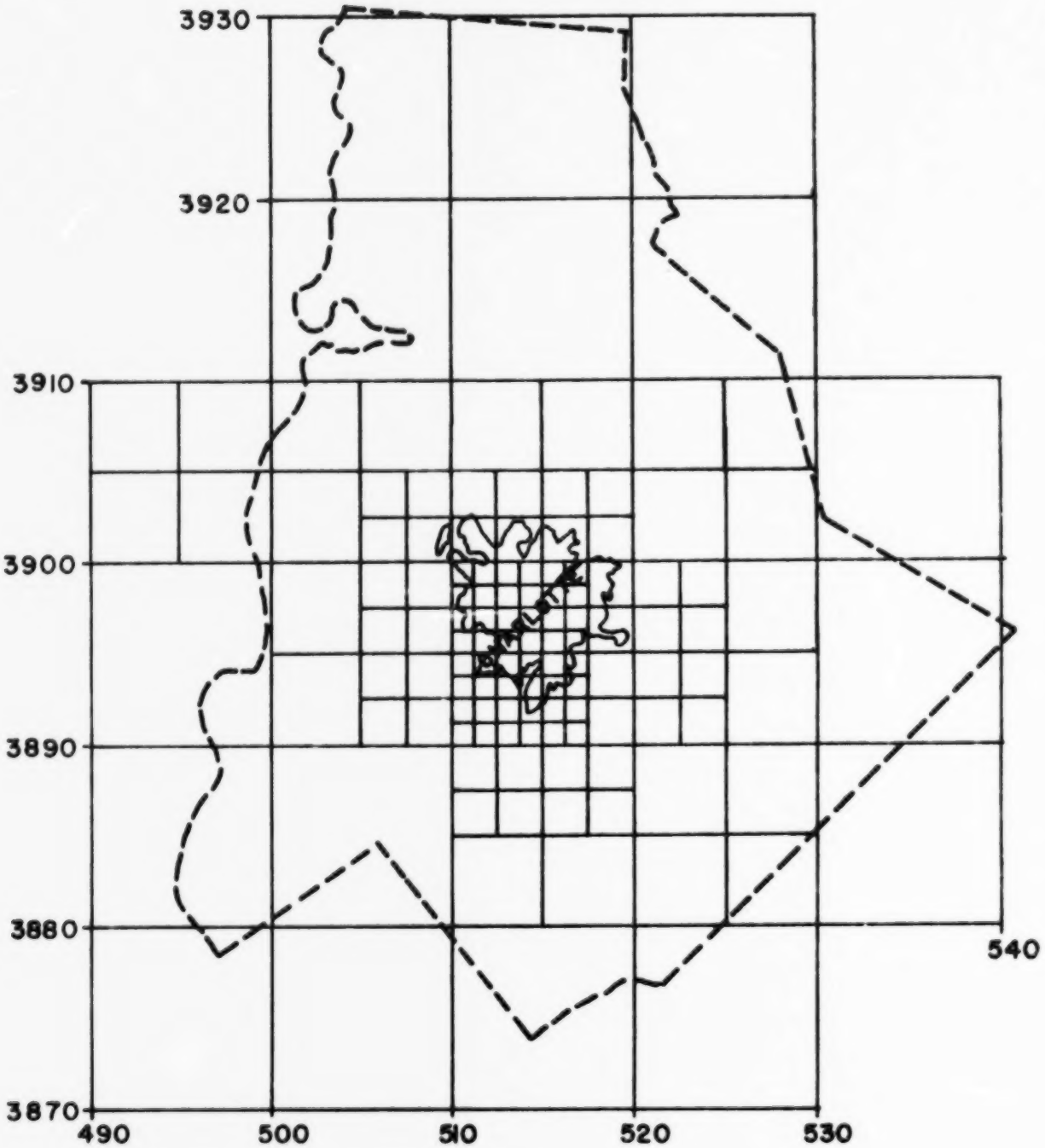


FIGURE II

WINSTON-SALEM AQMA: AREA SOURCE GRID NETWORK

(UTM Coordinates Shown)

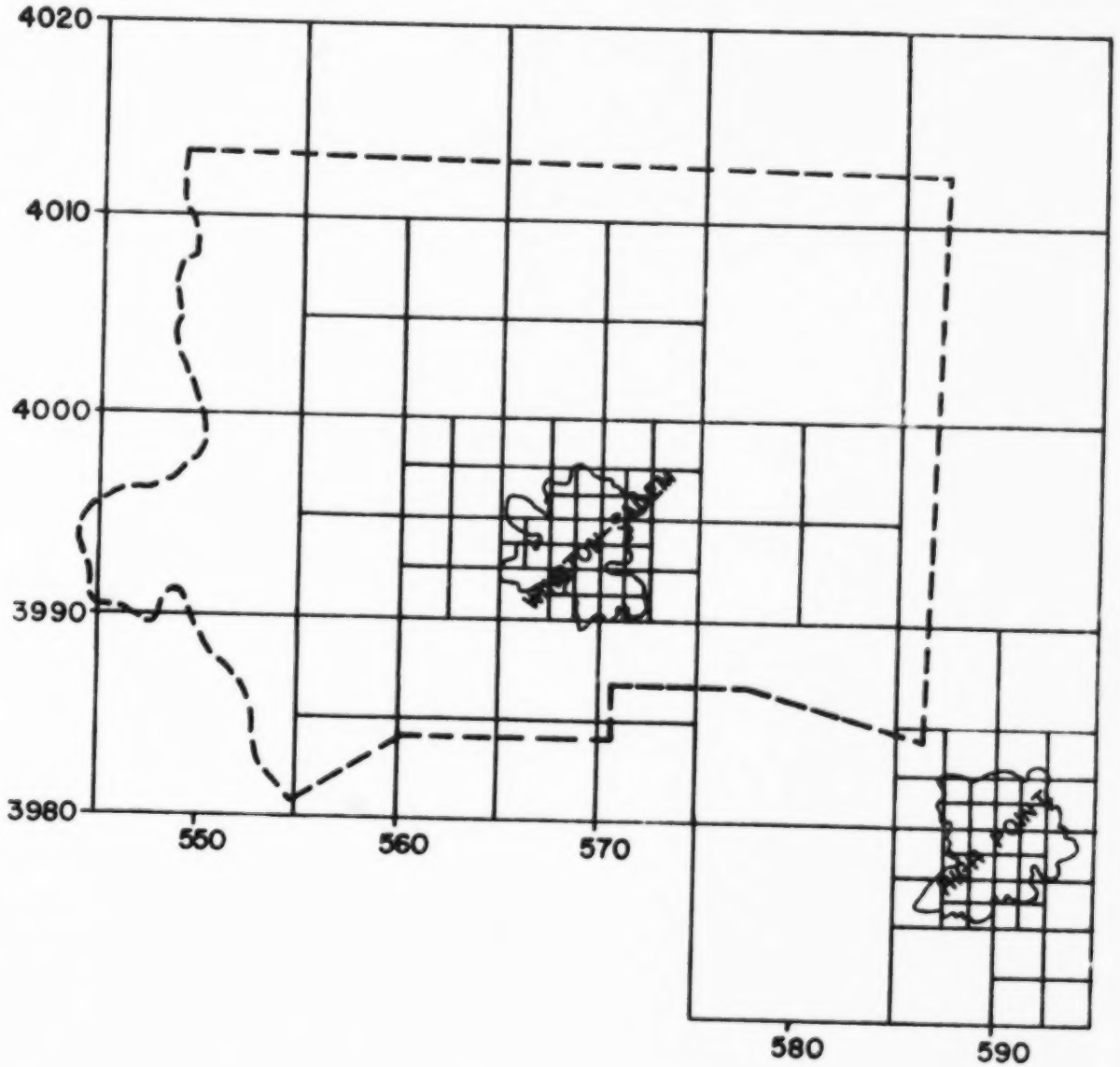
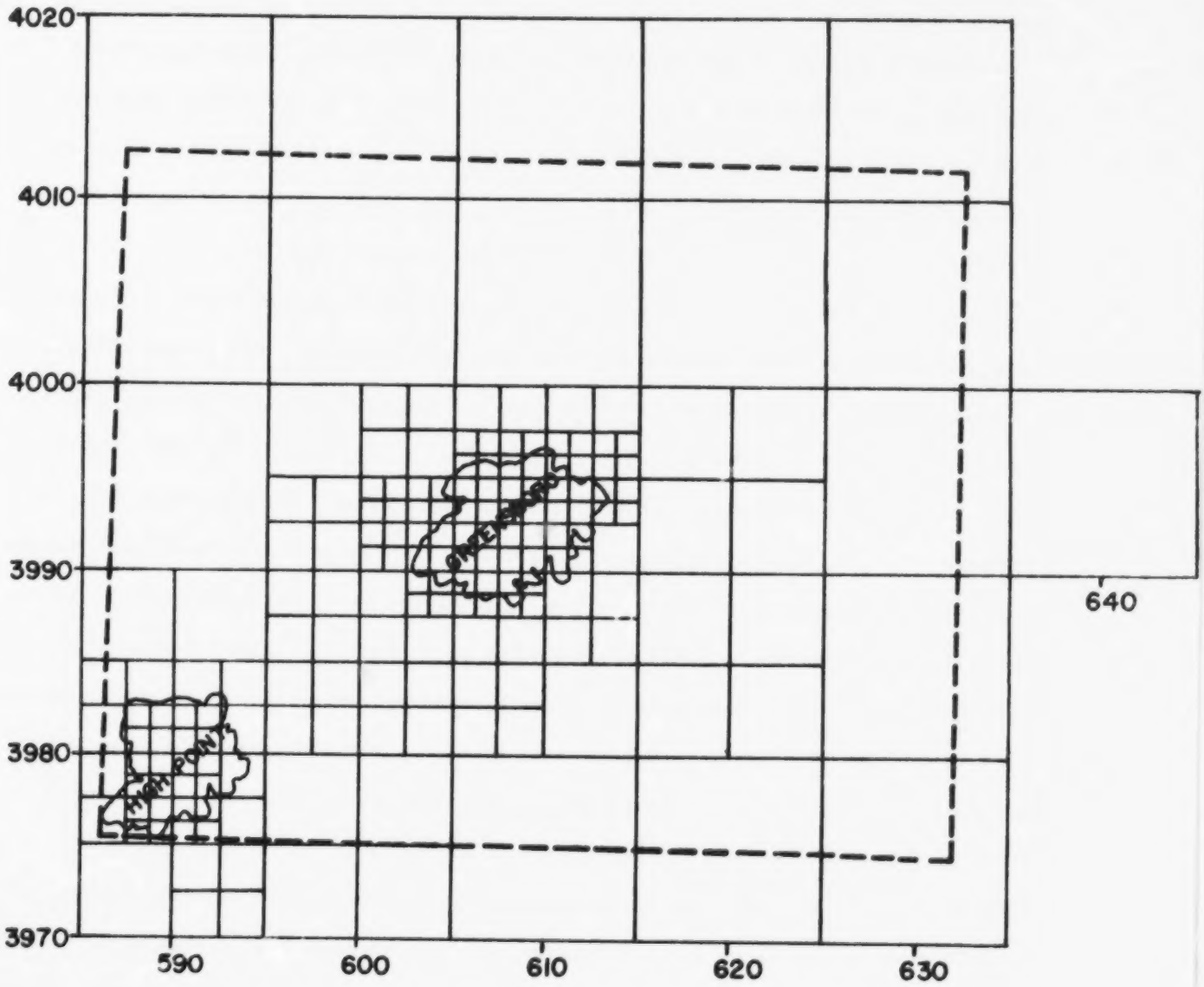


FIGURE III

GREENSBORO AQMA: AREA SOURCE GRID NETWORK

(UTM Coordinates Shown)



3.2.2 CHARLOTTE AQMA ANALYSIS

With respect to modeling the Charlotte AQMA, the inventory included meteorological data for Douglas Airport, representing the year of 1973 for calibration and the mean annual stability wind roses based on the five year period of January 1, 1969, through December 31, 1973, for projection. The inventory also included data for 97 point sources for the calibration year 1973, 93 point sources for 1975, 95 point sources for 1980, 97 point sources for 1985, and 123 area source emission grid allocations for all years. Using the modified air quality data for 1973 from the eight monitoring stations in the AQMA, which were found suitable for modeling purposes, the AQDM calculated a final regression equation having a slope of 0.8194, an intercept of 31.6, a computed correlation of 0.928, with a 5% confidence correlation of 0.707. Figure IV is a graph of the calculated versus observed concentrations for 1973 in the Charlotte AQMA.

A 4 km x 4 km rectangular grid having 180 receptors and 12 extra non-grid receptors was used in the model output. The AQDM-calculated concentrations at each receptor were plotted for each year, and isopleth analyses for the Charlotte AQMA for 1973, 1975, 1980, and 1985 are presented in Figures V, VI, VII, and VIII. Table IV presents an analysis of the point and area source contributions for the receptor with the highest calculated concentrations in the Charlotte AQMA for each year. Source contribution analyses for the five receptors with the highest calculated concentrations for 1973 may be found in Volume III. These analyses illustrate the overwhelming effect of area sources on AQDM calculated concentrations

The 1973 isopleth analysis shown in Figure V correlates with actual observed values for 1973 to the extent of the acceptability of the calibration. A strict interpretation of the projection years' isopleth analyses as shown in Figures VI, VII, and VIII indicates an increase in ambient TSP concentrations generally in the range of 1 - 1 1/2 $\mu g/m^3$ per year through 1985. This might suggest maintenance problems in the Charlotte AQMA, most apparently in and about the metropolitan area of Charlotte. The reader is again referred to Section 4 of this Volume for a more detailed interpretation.

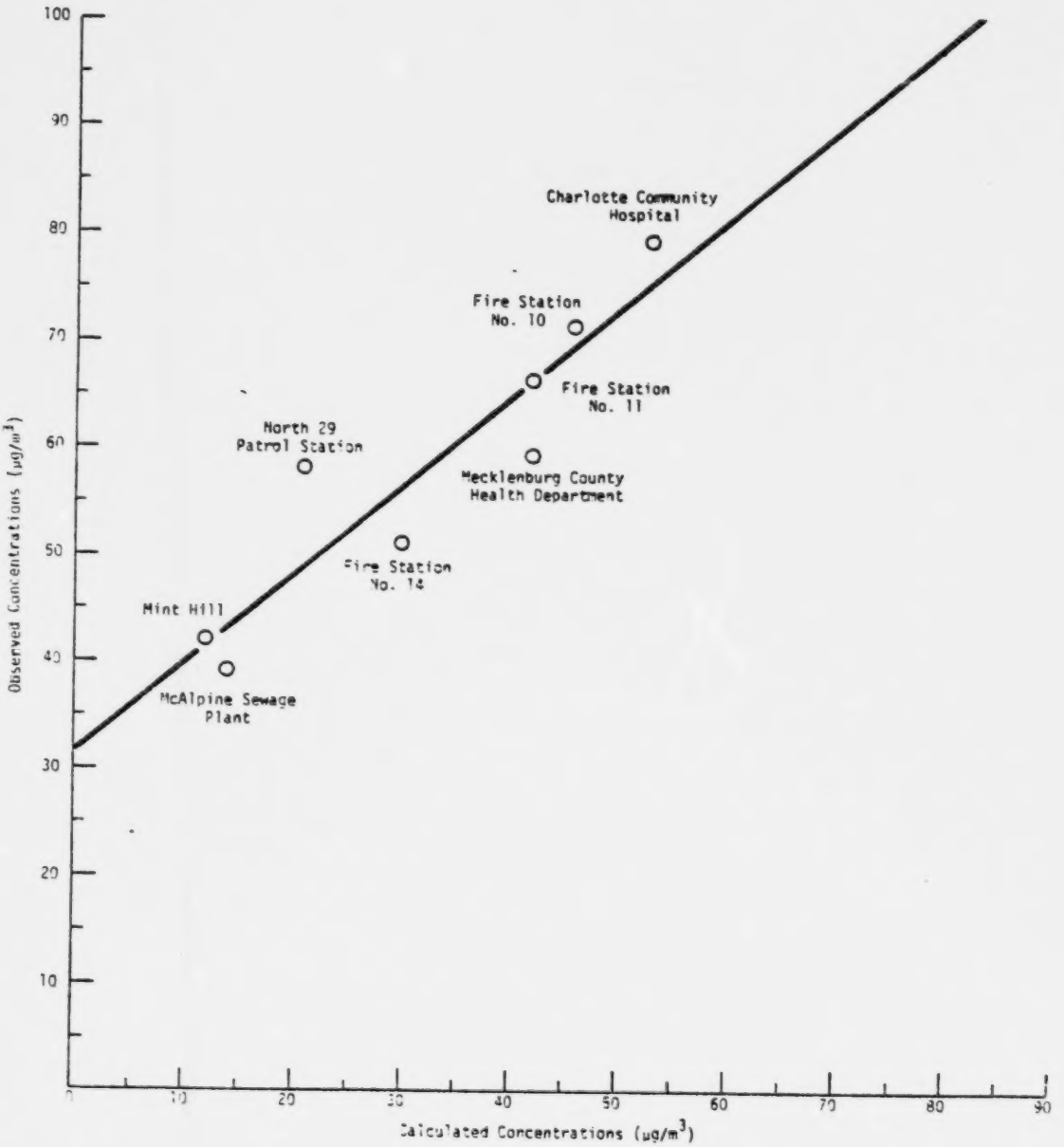


FIGURE IV

1973 FINAL CALIBRATION FOR THE CHARLOTTE AQMA
(TSP ANNUAL ARITHMETIC AVERAGE)

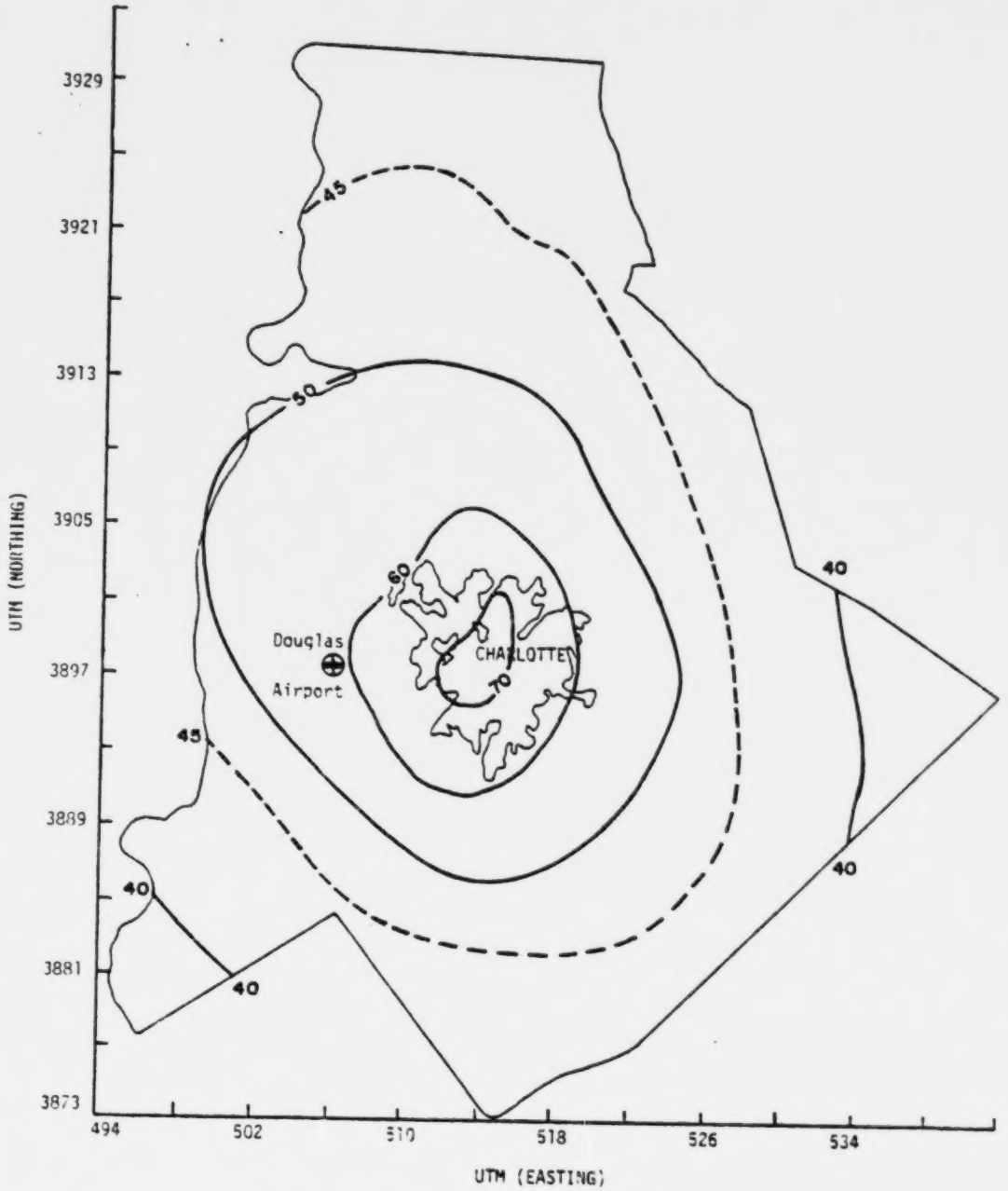


FIGURE V

CHARLOTTE AQMA: 1973 (CALIBRATION) ANNUAL ARITHMETIC MEAN TSP CONCENTRATIONS ($\mu g/m^3$)

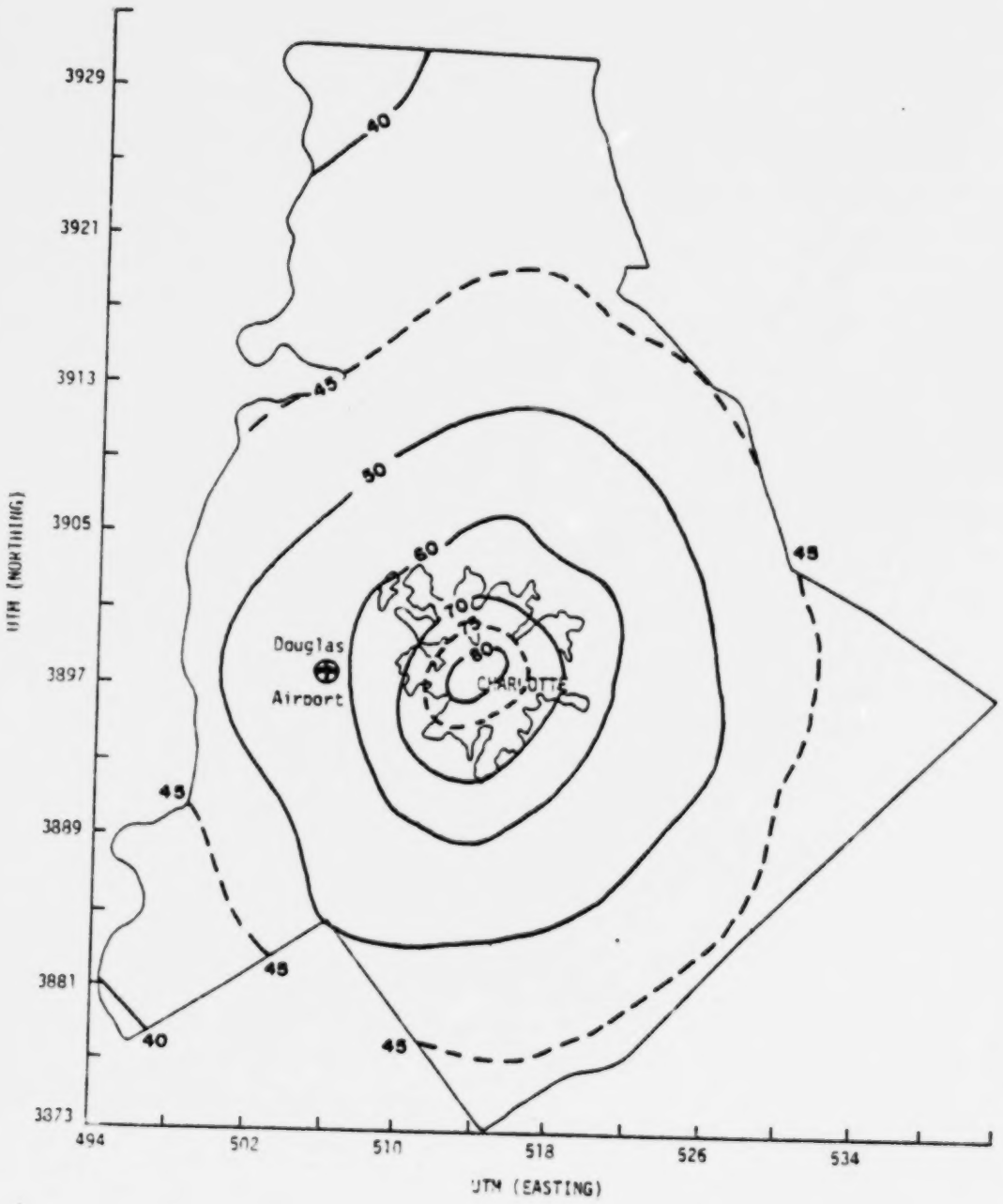


FIGURE VI

CHARLOTTE AQMA: 1975 PROJECTED ANNUAL ARITHMETIC MEAN TSP CONCENTRATIONS ($\mu g/m^3$)

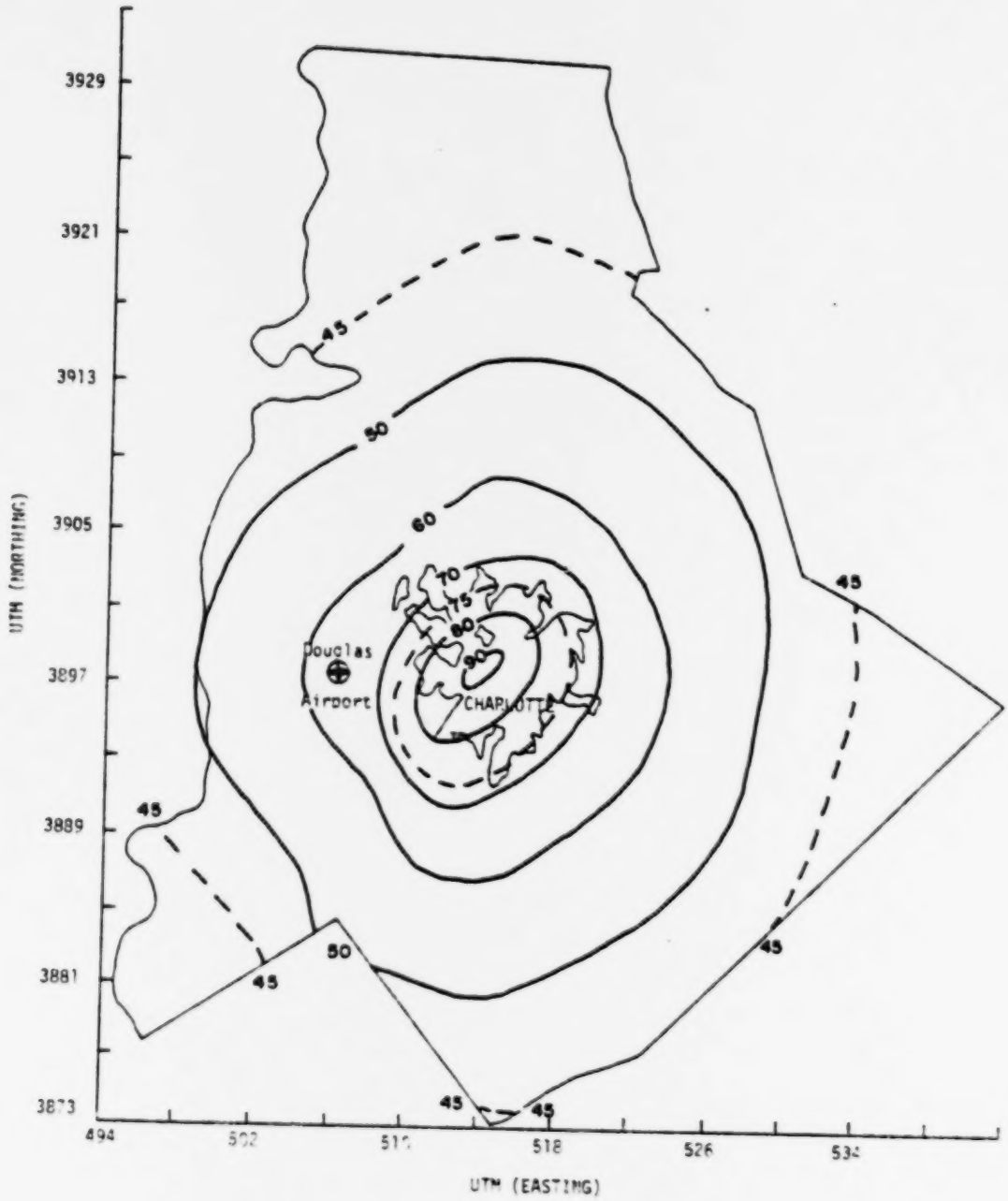


FIGURE VII

CHARLOTTE AQMA: 1980 PROJECTED ANNUAL ARITHMETIC MEAN TSP CONCENTRATIONS ($\mu g/m^3$)

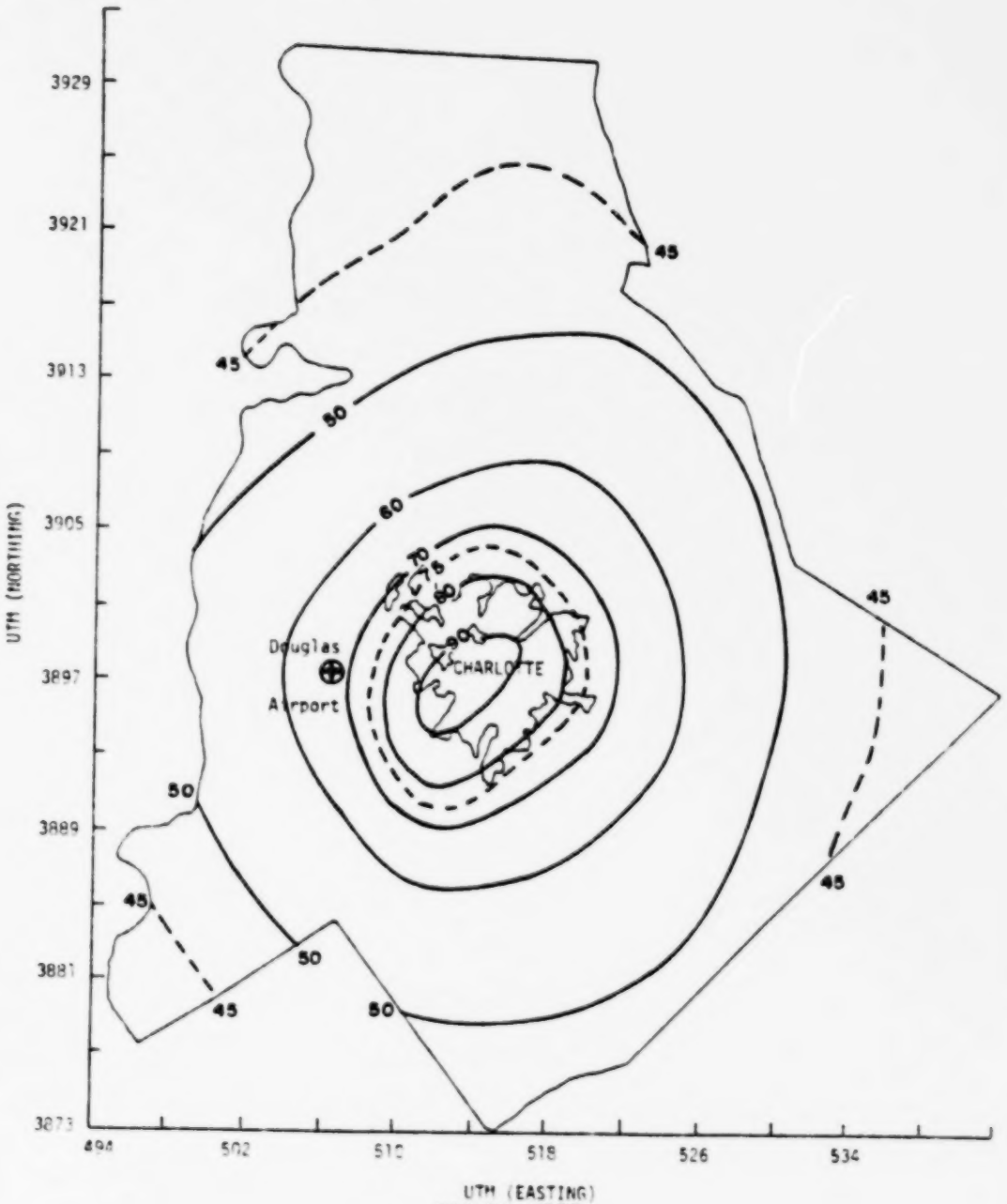


FIGURE VIII

CHARLOTTE AQMA: 1985 PROJECTED ANNUAL ARITHMETIC MEAN TSP CONCENTRATIONS ($\mu g/m^3$)

TABLE IV

CHARLOTTE AQMA SOURCE CONTRIBUTIONS TO RECEPTOR WITH HIGHEST CALCULATED CONCENTRATIONS

(From AQDM Source Contribution Tables)

Year	Receptor	Receptor Location (Kilometers) HORIZ	VERT	Point Source Contribution (Percent)	Area Source Contribution (Percent)	Total Concentration at Receptor (Micrograms/Cu. Meter)
1973	82	514.0	3897.0	7.00	93.00	73.03
1975	82	514.0	3897.0	3.36	96.64	82.54
1980	82	514.0	3897.0	3.34	96.66	92.14
1985	82	514.0	3897.0	3.40	96.60	99.69

3.2.3 WINSTON-SALEM/GREENSBORO AQMAS ANALYSIS

With respect to modeling the Winston-Salem and Greensboro AQMAs as one area, the inventory included meteorological data for the Greensboro-High Point-Winston-Salem Airport, representing the year of 1973 for calibration and the mean annual stability wind roses based on the five year period of January 1, 1968, through December 31, 1972, for projection. The inventory also included data for 255 point sources for 1973, 304 point sources for 1975, 313 point sources for 1980, 324 point sources for 1985, and 253 area source emission grid allocations for all years. Using the modified air quality data for 1973 from the ten monitoring stations in the two-county area which were characteristically acceptable for modeling purposes, the AQDM calculated a final regression equation having a slope of 0.8204, and intercept of 23.1, and a computed correlation of 0.705 with a 5% confidence correlation of 0.632. Figure IX is a graph of the calculated versus observed concentrations for 1973 in the combined Winston-Salem/Greensboro AQMAs.

A 5 km x 5 km rectangular grid having 180 receptors and 12 extra non-grid receptors was used. The ADQM-calculated concentrations at each receptor were plotted for each year, and isopleth analyses for the Winston-Salem AQMA and the Greensboro AQMA for 1973, 1975, 1980, and 1985 are presented separately in Figures X, XI, XII, and XIII and Figures XIV, XV, XVI, and XVII, respectively. Table V presents an analysis of the source contribution, point and area, for the receptor with the highest calculated concentrations in the two-county area for each year. A more detailed source contribution analysis for 1973, similar to that presented for the Charlotte AQMA, is also available for the Winston-Salem/Greensboro AQMAs in Volume III. These source contribution snalyses again illustrate the surprising effect of area sources on calculated concentrations.

In the Winston-Salem AQMA, the isopleth analyses indicate the same general range of increase in ambient TSP concentrations of 1 - 1 1/2 $\mu g/m^3$ per year through 1985 in the metropolitan area of Winston-Salem as is indicated in the

Charlotte area. The major difference shows higher magnitudes of calculated concentrations, on the order of 5 - 10 $\mu g/m^3$, in the Winston-Salem AQMA metropolitan area as compared to that of the Charlotte AQMA. Observed values in the two areas seem to generally substantiate this variance. These isopleth analyses alone would indicate maintenance problems in the Winston-Salem AQMA.

The isopleth analyses for the Greensboro AQMA show predicted concentrations also well above the NAAQS in both the metropolitan areas of Greensboro and High Point. The projected concentrations in and about Greensboro follow the same general increase per year as those of Winston-Salem and Charlotte; however, the calculated values in the Greensboro metropolitan area are on the order of 20 $\mu g/m^3$ above those in the Winston-Salem metropolitan area. The projected concentrations in and about High Point appear to remain generally stable, if not slightly improving over the short run. The concentrations projected in the Greensboro AQMA like those in the Charlotte and Winston-Salem AQMAs are consistantly above the NAAQS, indicating maintenance problems if the projected values alone are considered.

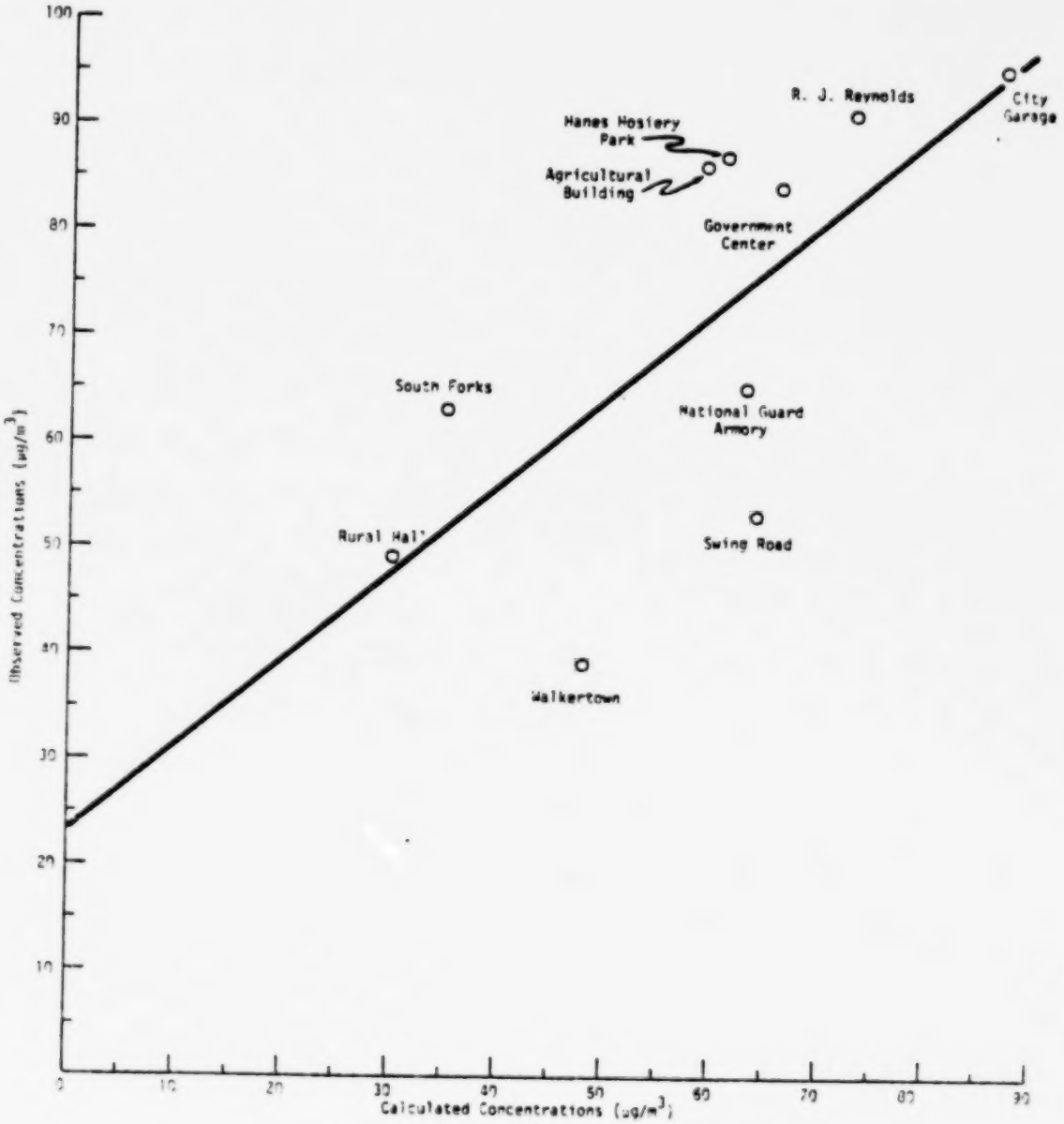


FIGURE IX

1973 FINAL CALIBRATION FOR THE WINSTON-SALEM/GREENSBORO AQMAS
(TSP ANNUAL ARITHMETIC AVERAGE)

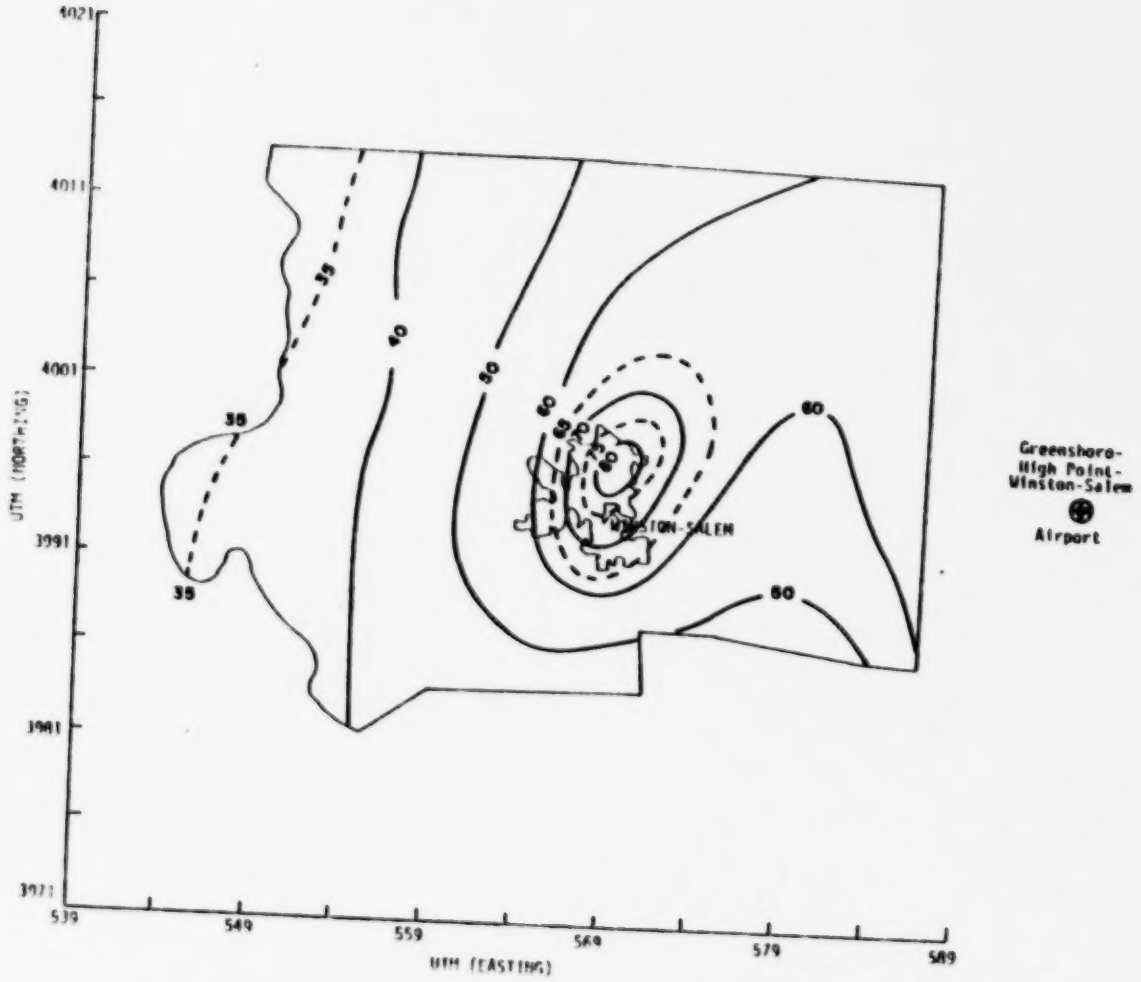


FIGURE X

WINSTON-SALEM AQMA: 1973 (CALIBRATION) ANNUAL ARITHMETIC MEAN TSP CONCENTRATIONS ($\mu g/m^3$)

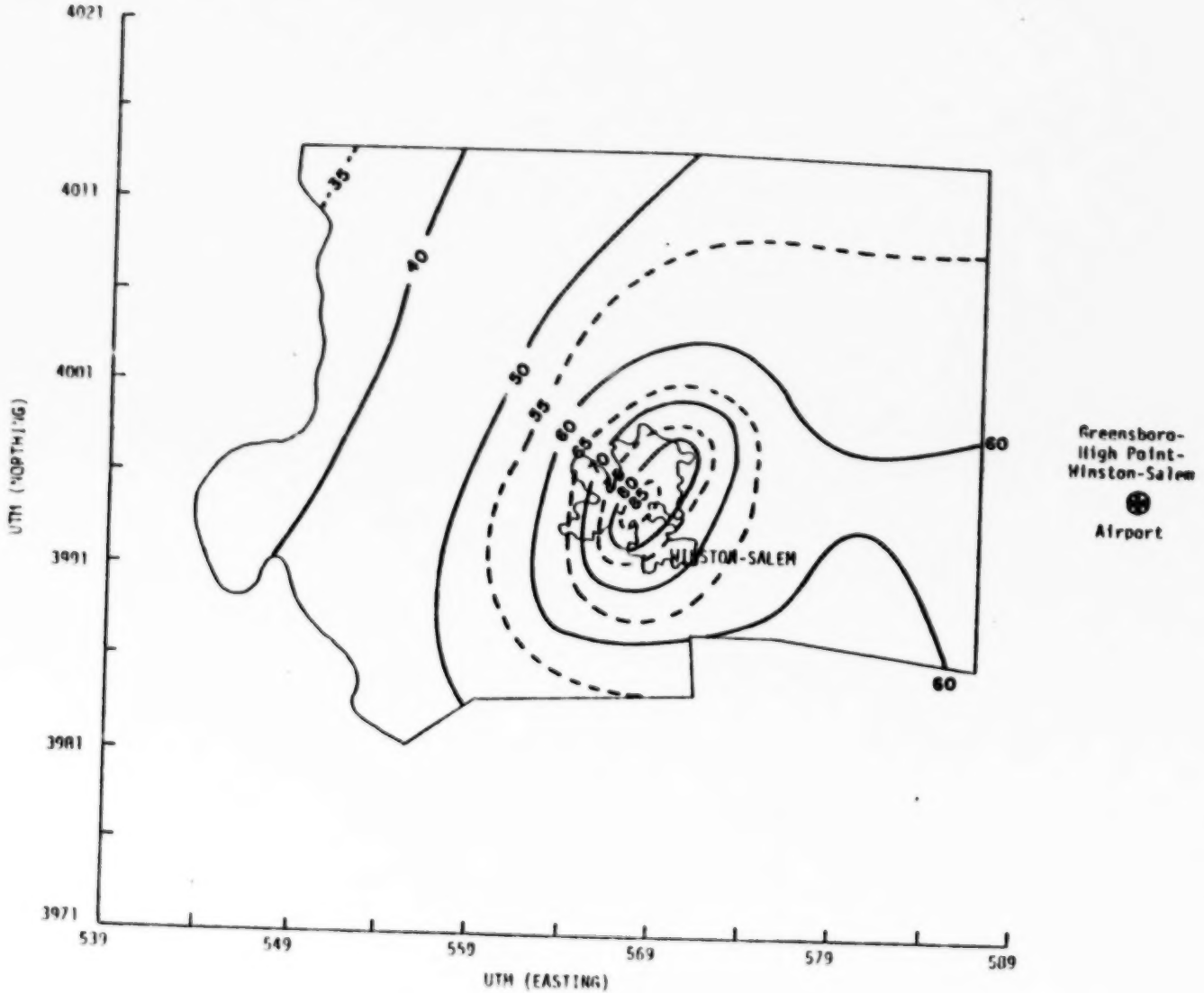


FIGURE XI

WINSTON-SALEM AQMA: 1975 PROJECTED ANNUAL ARITHMETIC MEAN TSP CONCENTRATIONS ($\mu g/m^3$)

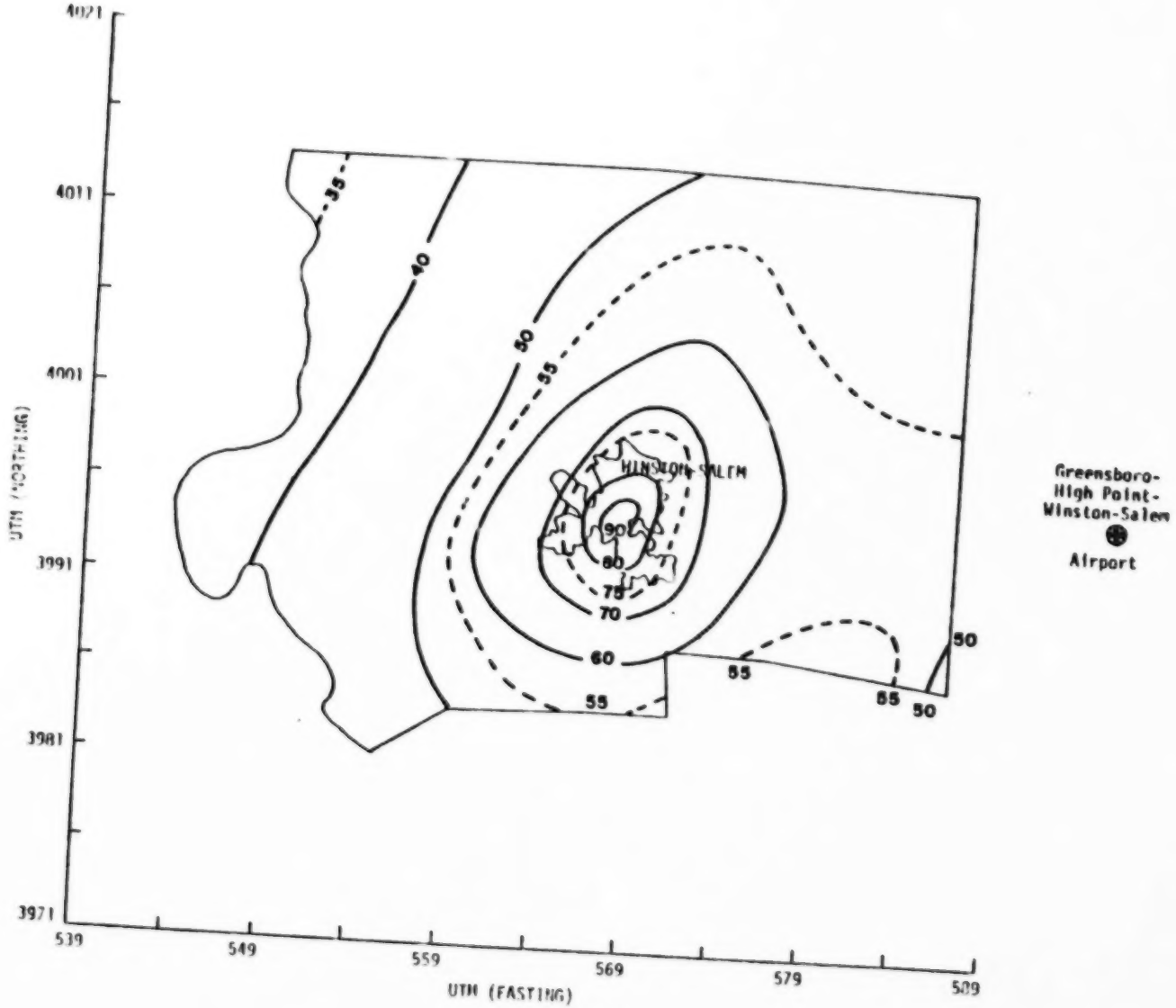


FIGURE XII

WINSTON-SALEM AQMA: 1980 PROJECTED ANNUAL ARITHMETIC MEAN TSP CONCENTRATIONS ($\mu g/m^3$)

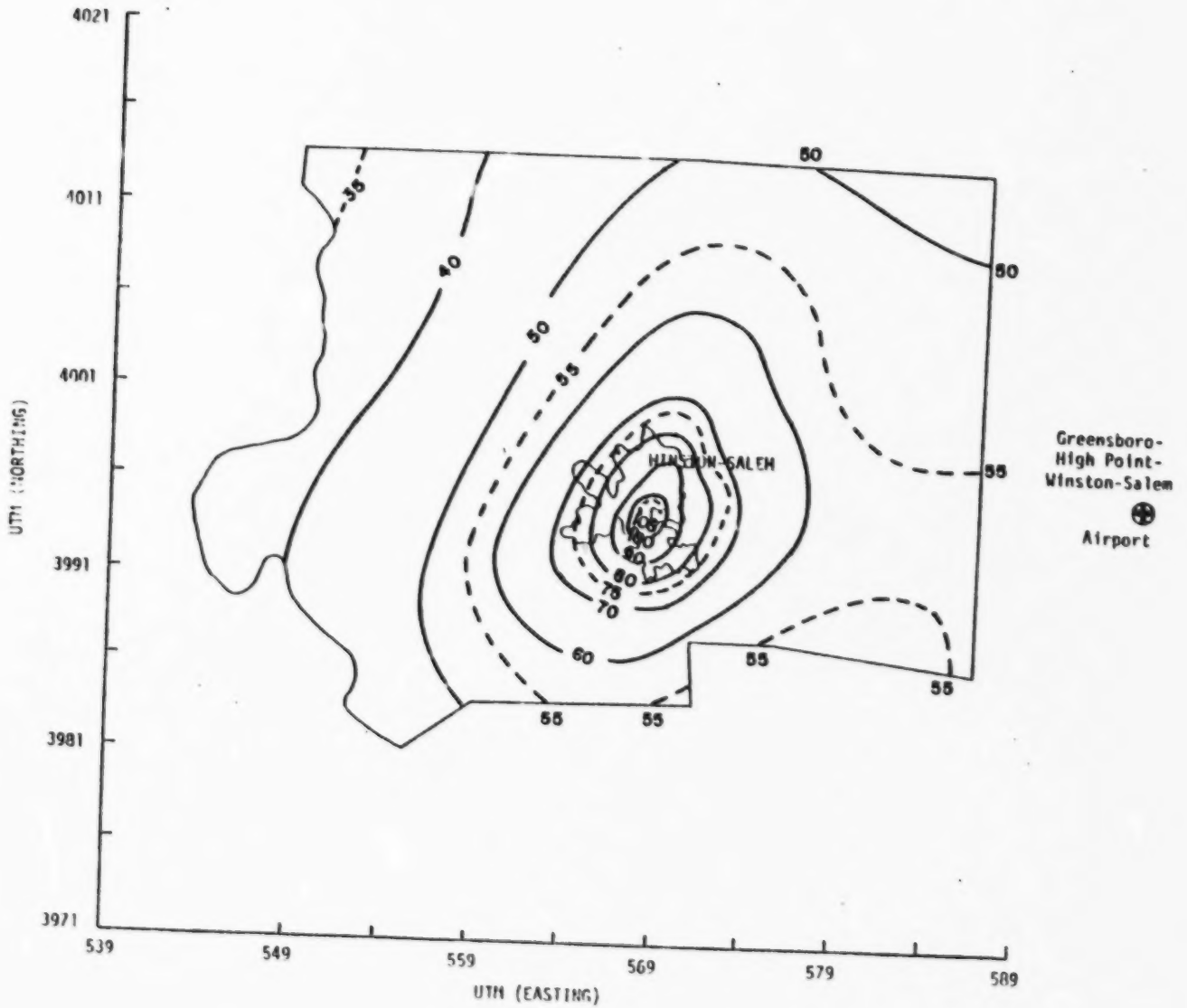


FIGURE XIII

WINSTON-SALEM AQMA: 1985 PROJECTED ANNUAL ARITHMETIC MEAN
TSP CONCENTRATIONS ($\mu g/m^3$)

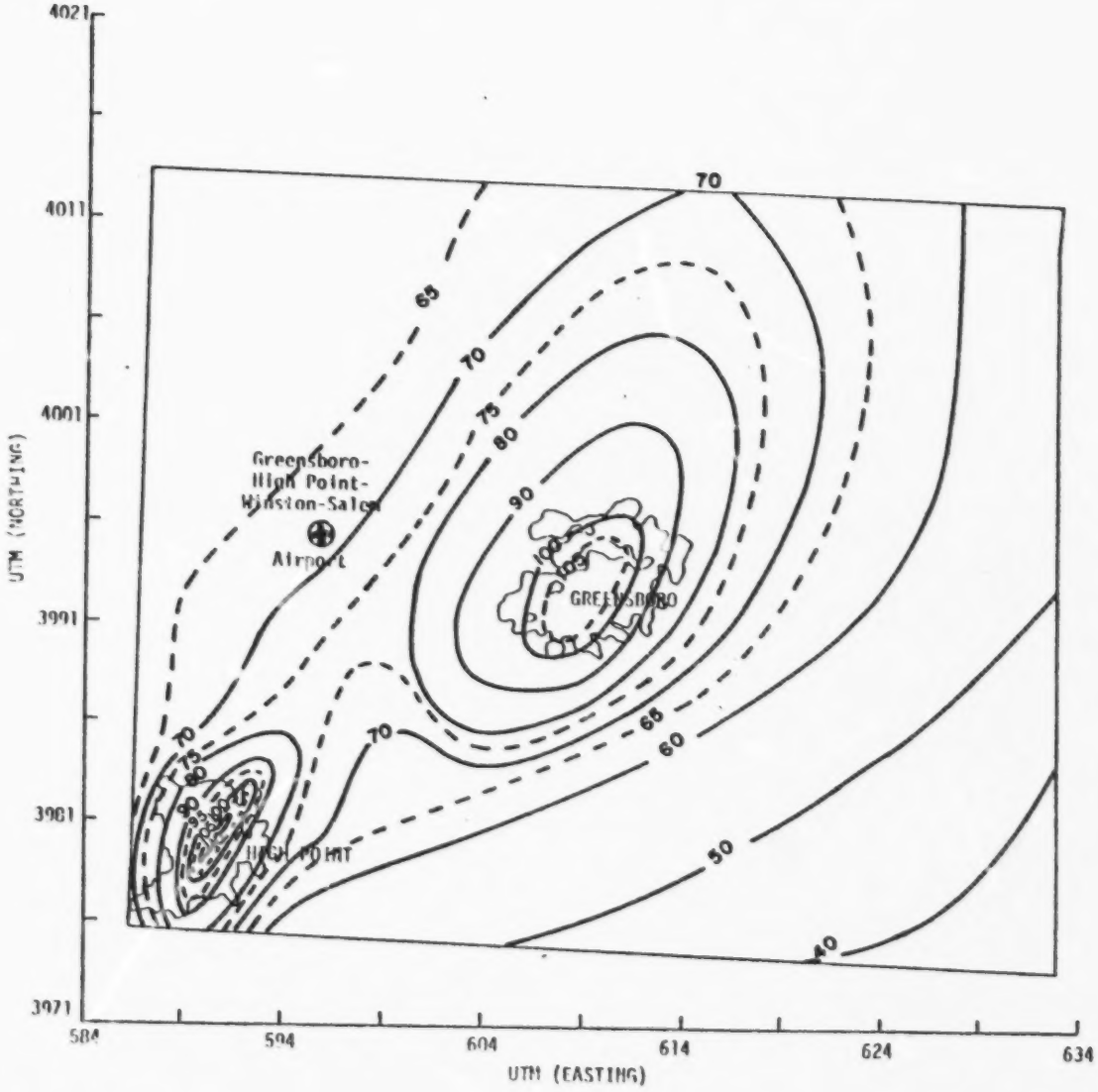


FIGURE XIV

GREENSBORO AQMA: 1973 (CALIBRATION) ANNUAL ARITHMETIC MEAN TSP CONCENTRATIONS ($\mu g/m^3$)

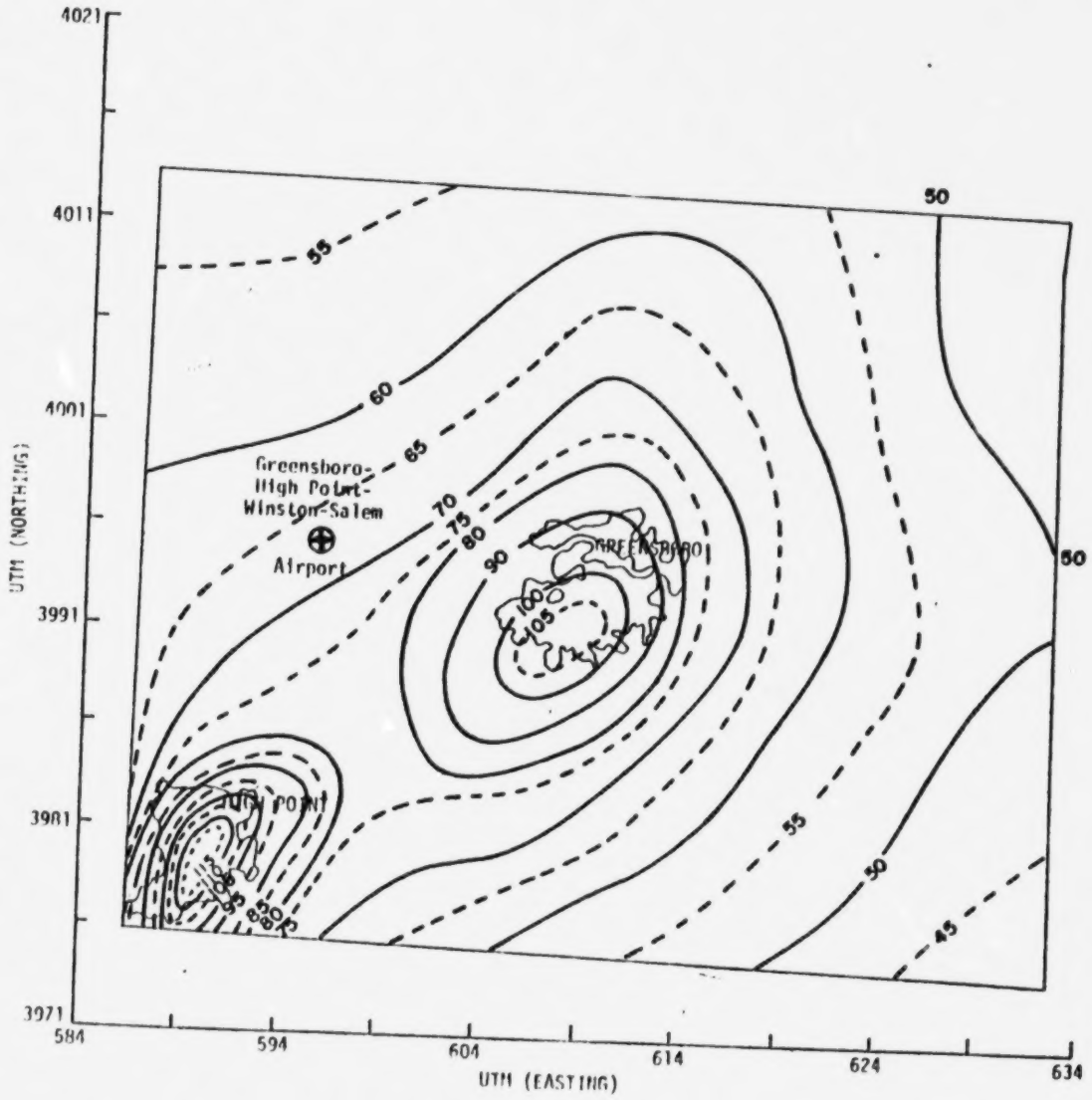


FIGURE XV

GREENSBORO AQMA: 1975 PROJECTED ANNUAL ARITHMETIC MEAN
TSP CONCENTRATIONS ($\mu g/m^3$)

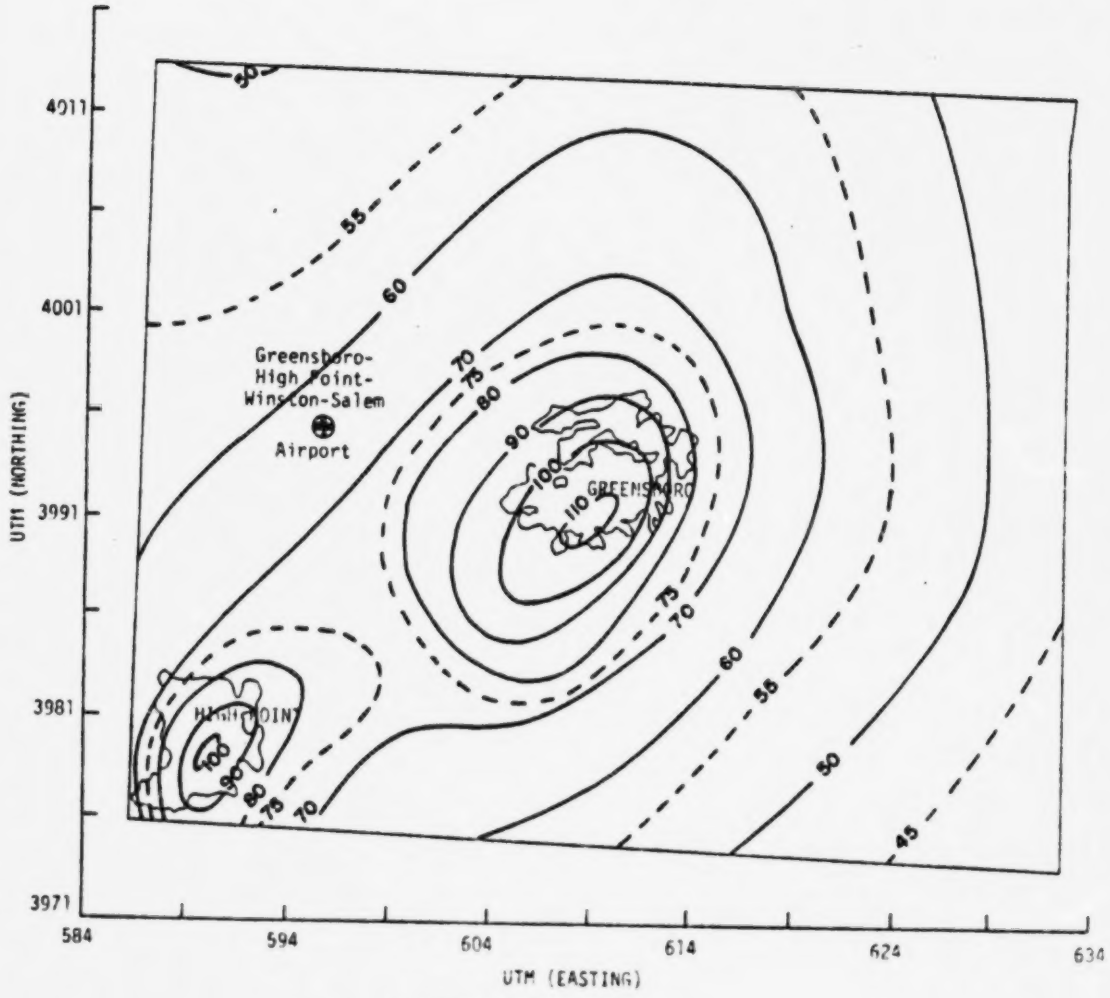


FIGURE XVI

GREENSBORO AQMA: 1980 PROJECTED ANNUAL ARITHMETIC MEAN
TSP CONCENTRATIONS ($\mu g/m^3$)

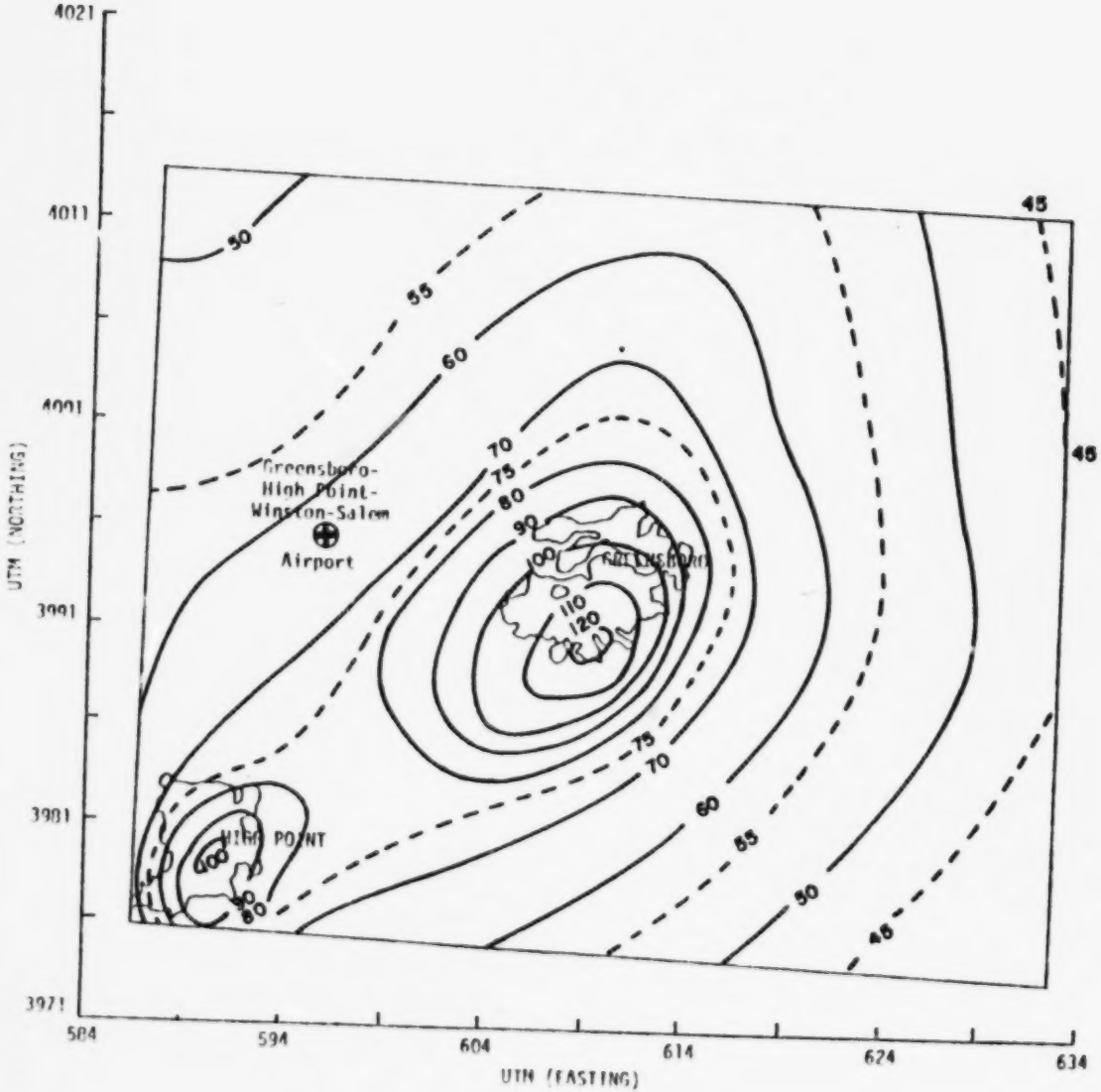


FIGURE XVII

GREENSBORO AQMA: 1985 PROJECTED ANNUAL ARITHMETIC MEAN TSP CONCENTRATIONS ($\mu g/m^3$)

TABLE V

WINSTON-SALEM/GREENSBORO AQMAS

SOURCE CONTRIBUTIONS TO RECEPTOR WITH HIGHEST CALCULATED CONCENTRATIONS

(From AQDM Source Contribution Tables)

Year	Receptor	Receptor Location (Kilometers) HORIZ	VERT	Point Source Contribution (Percent)	Area Source Contribution (Percent)	Total Concentration at Receptor (Micrograms/Cu. Meter)
1973	S. Main-W. Green	589.6	3979.1	32.53	67.47	113.95
1975	S. Main-W. Green	589.6	3979.1	25.66	74.34	116.95
1980	135	609.0	3991.0	11.74	88.26	114.60
1985	135	609.0	3991.0	11.97	88.03	121.28

4. VALIDITY FACTORS

4.1 GENERAL

As was mentioned in the preceding Section, confidence in the accuracy of any prediction modeling effort should be carefully considered prior to drawing conclusions from the results which would require new policy implementations. The input data and computational techniques incorporated in area wide dispersion modeling, such as those which have been used in this analysis, can predict values in future years which can be expected to agree with actual values only to the extent that the quantitative input parameters are realistically identified and projected in accordance with actual growth. Secondly, the validity of such predicted values is again dependent upon the soundness, both technical and statistical, of the theoretical prediction model used. This discussion does not attempt to question the usefulness of climatological models such as the AQDM, but attempts to make clear some of the uncertainties and variables which are inherent in the preparation of the input data and the modeling techniques themselves. Incomplete agreement or a less than perfect correlation between predicted and actual values certainly does not preclude the possible usefulness of the modeling output.

As a result of the time lapse during the analysis, there arose a rather unusual and certainly an informative situation, whereby it became possible to actually compare those predicted concentration values calculated by the AQDM for 1975 to the observed concentrations for 1975 at each monitoring site. Table VI presents such a comparison for each monitoring site used in the modeling effort. Having this comparison capability allows for inferences to be drawn about the validity of the projections made for 1975. Insofar as such inferences can only be derived from comparing the values from a total of 18 receptors in a three county area, the reader is cautioned against over generalizing by assuming that these 18 receptor locations can be construed as being representative of the total geographical areas of the three AQMAs. This is not to imply that a comparison

of the observed versus calculated values is not useful.

Table VI indicates that the projection has, in general, uniformly overpredicted TSP concentrations for 1975. Further analysis of the values shows an average overprediction of 26% with a standard deviation of 17.5% for the three AQMAs combined. More specifically, the AQDM has overpredicted concentrations by 37% with a standard deviation of 17.1% in the Charlotte AQMA and by 18% with a standard deviation of 12.8% in the Winston-Salem/Greensboro AQMA area.

This comparison of the 1975 predicted and observed concentrations spurred a great deal of interest and was the subject of many discussions concerning possible causes for such a dramatic variance. The remainder of this Section identifies those questionable areas which the participants in the AQMA analysis feel may have, at least in part, contributed to the variance in the 1975 concentrations. This discussion should not be interpreted as discreditating or disclaiming any work done in any phase of North Carolina's AQMA analysis.

There is no attempt in this Volume to quantify any of the variables suggested, as time has not permitted detailed reassessments and research of questionable areas. It is the intent of the NCAQS, as discussed in Section 5, to develop and maintain a program whereby appropriate demographic, economic, and meteorological parameters will be periodically updated.

TABLE VI

1975 OBSERVED AND AQDM PREDICTED ANNUAL TSP CONCENTRATIONS

SAROAD NUMBER	MONITORING STATION	ARITHMETIC MEANS IN $\mu g/m^3$ SAROAD OBSERVED TSP ($\mu g/m^3$)	AQDM PREDICTED TSP ($\mu g/m^3$)
	Charlotte AQMA		
34-0700-010	Fire Station #10	56	74
34-0700-003	Fire Station #11	56	70
34-0700-004	Fire Station #14	42	62
34-0700-002	Charlotte Community Hospital	60	82
34-0700-011	County Health Department	45	74
34-2580-001	Mint Hill	42	44
34-0700-008	North 29 Patrol Station	41	53
34-0700-014	McAlpine Creek Sewage Plant	31	47
	Winston-Salem AQMA		
34-4460-008	Government Center	64	86
34-4460-002	Agricultural Building	72	78
34-4460-009	Hanes Hosiery Park	69	71
34-4460-003	Patterson Avenue(R.J. Reynolds)	82	89
34-1480-002	Rural Hall	47	46
34-4460-005	South Fork	53	59
34-1480-001	Walkertown	43	56
	Greensboro AQMA		
34-1740-002	City Garage	87	102
34-1780-010	Swing Road	58	73
34-2000-003	National Guard Armory	65	91

4.2 ECONOMIC VARIABLES

The predicted concentrations for 1975 were based on projections from the year 1973 with that year's relatively healthy state of the economy. The recessionary period occurring after 1973 and vastly invluencing economic growth during the 1973 through 1975 period may have caused a substantial variance in many economic related activities, causing them to experience less growth during the duration than originally predicted. This situation raised significant questions over the economic-related projection parameters.

Obvious examples of an economic-related cause for variance might be the overoptimistic projections of both known point source growth, estimated by the individual sources themselves, and unknown point source growth derived from local planning agencies employment projections. Such overpredictions would give overestimates of fuel combustion and process loss emissions for 1975.

Another economic factor might be the general decline in construction activities during this period, such as new highways, paving unpaved roads, housing starts, and retail and commercial developments as opposed to the optimistic projections of such activities. This decline in activity could have caused overestimates of area source fugitive dust, with the exception of reduced paving of unpaved roads which might cause an underestimate of fugitive dust emissions.

The surpressing influences of the economic situation after 1973 may have caused projections of emissions directly related to vehicle miles traveled (VMT) to be highly overestimated for 1975. Preliminary contact with the North Carolina Department of Transportation and Highway Safety appears to substantiate this assumption. Also, VMT was projected through extrapolations from historical data at a rather large rate of increase. This historical data was based on the urban growth of VMT in the AQMAs; and, since no rural data was available, the urban growth rate was assumed in the projection of VMT in the rural areas. If urban VMT growth was not representative of rural VMT growth, possible variances

in the projected concentrations could have arisen through that assumption. Because of decreased VMT activity due to fuel scarcity and inflating prices of gasoline, fugitive dust emissions from paved and unpaved roads and tailpipe emissions may have been overestimated. Another consideration in this category might be the nationwide decrease in the maximum allowable speed on primary roads to 55 mph. This could have possibly caused an overestimation of the projected emissions of fugitive dust from many paved roads, as such emissions are directly related to vehicle speed. Another variable might be the change in vehicle mix, as more and more "economy" vehicles were purchased during this period. Such a change could possible affect the AP-42 tailpipe emission factor used for 1975, which was based on a previously assumed vehicle mix.

During the recessionary period since 1973, many energy conservation measures have been implemented by both the industrial and private sectors. Such conservation practices, wherever combustion fuel is related, (i.e., industrial manufacturing and processing, space heating, vehicular consumption, etc.) could have caused variances between projected and actual 1975 fuel consumption again giving an overestimation of emissions.

4.3 METEOROLOGICAL VARIABLES

Because of the importance of representing meteorological conditions properly in a climatological dispersion model such as the AQDM, there is some concern over using long-term five year average meteorological parameters for a specific year in the future, such as 1975. If 1975 were not a year having "average" meteorological characteristics, significant discrepancies might be expected. Such factors as the amount and duration of rainfall, the actual wind speed and frequency distribution, the actual mean temperature, and the actual number of days with poor dispersion characteristics, if misrepresented in the prediction for 1975, might have caused considerable variances between calculated and observed concentrations. A recent preliminary assessment of the

actual versus projected 1975 meteorological conditions has not identified any major misrepresentation, but a more detailed investigation is felt to be necessary.

There is also a significant restriction on the spatial variation of the meteorological characteristics allowed, since the meteorological data is usually obtained for a single location such as the nearest airport, which may or may not be representative of the area being modeled.

4.4 MODELING VARIABLES

The overprediction of TSP concentrations by the AQDM for 1975, as compared to actual observed concentrations, could have had possible influences from inherent characteristics of the model itself.

The AQDM, like most climatological dispersion models, assumes a flat terrain. It is felt that the three AQMAs are topographically level enough to be realistically represented in the AQDM. In the urban areas, "street canyon effects" might cause the channeling of winds and localized disturbances of the wind field which cannot be accounted for in the model, and could cause some misrepresentation in the predicted concentrations in the metropolitan centers.

Another inherent characteristic of AQDM is the level of mathematical approximation of the area sources, since AQDM treats area sources as "virtual point sources." While AQDM was the recommended model for this analysis, there is some concern over the method of representation of the area sources.

Since meteorology and emissions may substantially vary from one season to another, there is a concern that seasonal and diurnal variations in both are generally not considered in such modeling as was performed for this analysis.

Another questionable area is the number and location of sampling stations used in the calibration of the AQDM. The AQDM user's manual recommends a minimum of 20 sites for use in calibration. However, only eight suitable sampling sites were available for the Charlotte AQMA and ten sites for the Winston-Salem/Greensboro AQMAs. The use of less than 20 sampling sites

for both modeling areas may have had an adverse affect on the calibrations. The sampling sites in the three AQMAs were not statistically located to be geographically representative of each area. Projecting air quality concentrations in all areas of an AQMA based on a calibration using sampling stations which may have been subjectively located, for source specific monitoring purposes or in urban areas because of public, political, or convenience priorities, might well have undesirable influences on their representativeness.

5. RECOMMENDATIONS

The NCAQS is recommending that various activities pertinent to the three AQMAs in North Carolina be carried out under the direction of State Air Quality personnel. The following recommendations shall be instituted through a defined program of reassessing, refining and updating related emissions and air quality data, tracking associated growth parameters, and reanalyzing future air quality through prediction modeling:

A. Substantiation of the emission inventories used and the degree to which the model correctly represents these inventories. As a first step, the NCAQS is currently involved, with the contractual assistance of RTI, in a microscopic analysis of statistically selected 1973 high-volume filters. This analysis of filters should help verify the large variance in magnitude between point and area source total emission inventories and between computed contributions.

B. Annual updating of both point and area source emission inventories. Such a continual process of updating the inventories of existing sources could allow for annual refinements of the projected growth parameters of each source which would ensure both comprehensiveness and accuracy of all associated inventory parameters.

C. Tracking of related demographic and economic growth parameters. These parameters would include population, employment, total earnings, manufacturing earnings, housing starts, and economic trends indicated by such data as general sales tax, gasoline tax and power demands.

D. Continuous updating and tracking of recorded and projected VMT data. Such information is being continuously assessed and is periodically available from various State and local agencies.

E. Research of all available information concerning existing and proposed energy conservation measures. Such measures might include changes in general fuel consumption by quantity or type through regulated or volunteer conservation programs affecting industry or private citizens.

F. Further investigation of the meteorological representativeness of short-term and long-term data available from airport weather stations. With respect to the concern expressed over using the five-year average meteorological parameters for calculating air quality concentrations in 1975 (as described in Section 4.3), the NCAQS is currently involved with the contractural assistance of RTI, in preparing a rerun of the AQDM for the Charlotte AQMA for 1975, using the actual meteorological data from that year. This reanalysis should serve as a comparison with the projected concentrations in the Charlotte AQMA which were based on average long-term data.

G. Continual reassessment of the ambient monitoring networks in the three AQMAs. Such investigations could assist in determining the applicability of recorded data from each monitoring station for use in further dispersion modeling analyses. Reassessments might also help define the degree to which number of sites and their locations can be expected to represent the ambient air quality of the total geographical areas.

H. Reanalysis of the area(s) using the best modeling methodology available. Modeling analyses will be performed at such time as the preceding actions signify a need to reassess any or

all of the three AQMAs in a detailed manner which could only be accomplished through area-wide dispersion modeling. As a first step in determining the most suitable model for predicting future air quality concentrations in the three AQMAs, EPA, Region IV has offered assistance to the NCAQS in running the Climatological Dispersion Model for 1975 for the Charlotte AQMA to comparatively analyze the output with that of the AQDM.